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Science Against Corrosion

Iron, steel, cast iron, and other metals and alloys not only serve as basic construction materials today, but will doubtless maintain this role for many years. Their mighty rivals -- plastic and polymer materials, modified wood, glass, ceramics, concrete and others both well known and putting in an appearance for the first time -- will not replace metal. A place will be found for each new structural material possessing excellent physical and physical-chemical qualities in the national economy and in the development of future technology. It is not for nothing that an increase in the production of non-metallic materials has been taking place right alongside an increase in the production of metals.

For this reason, there is much that is disturbing for mankind in the circumstance that the majority of the technological metals, with iron (steel and cast iron) in the front row, possess the tendency under the action of moisture, oxygen and other active agents to once again return to the oxidized state in which they were when they were still ore. Metal's instability in relation to corrosion is the tru Achilles heel in an over-all complex of characteristics which are extremely important to technology.

The famous American professor Herbert Uhlig Yulig has calculated that in the national economy of the USA (not including military technology or military technology) the loss from metal corrosion reaches six billion dollars per year!

Rough calculations show that about 10 to 12 percent of an extracted metal is irrevocably lost due to the dissipation of corrosion. This means that nearly every eighth blast furnace is working on corrosion! In our country, as was pointed out by N. S. Khrushchev in his speech before the plenum of the Central Committee of the Communist Party of the Soviet Union, the loss from the corrosion of ferrous metal amounts to almost eight million tons per year.

This is more than a simple problem of a large absolute quantity of metal

being eaten up by corrosion. Halts in construction are much more costly than just the value of some spoiled metal; on this we must place both the mind of the engineer and the skill of the worker. In many instances, the date of the construction activity will be determined by the struggle against corrosion, as for example, with underground gas pipelines, towers for high voltage wires, sea-going vessels, bridges, chemical apparatus, communications, steam boilers, and other equipment. Future technological progress in connection with, for example, "tamed" atomic energy, the development of rocket engines, the chemical industry and other aspects of the new technology will depend to a significant degree on the discovery of new and reliable metallic materials and on the perfection of means to protect them from corrosion.

The struggle against corrosion is not only a step for savings in the national economy and not only a way to preserve the natural resources of the country. When one considers that one of the effects of anti-corrosion measures will be to increase the reliability of elevator cables, boilers, pipes, and high pressure autoclaves, aircraft and ships, then the struggle against corrosion becomes a struggle for the saving of men's lives.

The importance of the true essence of investigating into the phenomenon of corrosion is not limited by superficial views but can be illustrated with facts from the annals of the history of technology.

Forty years ago, an American millionaire wanted to have a sea-going yacht that would be better than that belonging to anybody else. All the achievements of modern technology were considered in its construction. For covering the bottom, monel metal was chosen. This is an alloy composed 70% of nickel and 30% of copper; it is very expensive, but completely corrosion-proof. The keel, the bow, the stern, and the rudder frame were made of highly durable steel with an extra thickness which made possible extended use in salt water. However, it was not realized that the vast surface of the monel metal covering would act as the cathode of an enormous galvanic element and would antagonize the steel

the action of the destructive forces on the steel, which served as the anode. As a result, this expensive yacht, which cost its owner more than half a million dollars, regardless of its symbolic and poetic name "Call of the Sea", was taken out of service only a few months after its launching and scrapped without making a single voyage.

Undoubtedly in the case the builders displayed more zeal than sense. If zinc or a good elctrostatic iron had been used for covering the bottom of the yacht instead of the expensive monel, then the ship might have sailed for many years. Similar mistakes in the realm of protective metal construction caused by insufficient knowledge of the real meaning of the phenomenon have not been excluded from our own time either. That is why it is important to know how to fight against corrosion, using the newest protective measures developed by science. That is why it is so important to continue the steady development of by further scientific research into the problems of metal corrosion, for only on such a basis can the fight be successful.

By now, the reader will be asking the question: what actually has science taught us today about the fight against corrosion?

A great deal. Consider the fact that modern stainless steel, acid-resistant alloys, and heat-resistant alloys are the practical result of a great deal of scientific research. The discovery of stainless steel around fifty years ago was one of the first major victories in the battle with corrosion. Many chemical processes under production conditions would be impossible if the preparation equipment were not made of acid-resistant steel and other alloys. The contemporary rocket could not exist without heat-resistant structural alloys.

The cathode protection effect discovered more than one hundred years ago by the English scientist Davy has today been developed to such an extent that it is widely used in practice. One can safely say that cathode protection will keep modern underground main gas pipelines from corroding for an indefinitely

long period of time. Cathode protection has a special significance for the protection of underwater construction, sea port installations, ships, bridges, sluice gates, and boilers. According to American statistics, this method saves many millions of dollars in the USA every year.

Let us also discus several important results of the work carried on in the metal corrosion section of the Institute for Physical Chemistry of the Academy of Sciences of the USSR in recent years.

It has been shown, for example, that a slight addition of palladium (0.1 to 0.2 percent) to titanium or better yet to its alloy with chrome or molybdenum creates an alloy with an exceptionally high resistance to corrosion. This alloy is not affected by such oxidizing acids as nitric acid or by such non-oxidizing acids as sulphuric or hydrochloric acid. This combination is extremely important for technology. And it was only a short time ago that it was believed that further additions of positive components to an alloy only weakened its chemical stability.

Even the random alternating current in the ground has been successfully won over to the side of mankind. Its destructive effects on underground equipment are well known. With the introduction of a protective cathode near a pipeline, for instance, the destroyer becomes a protector!

For stainless steel, for titanium and its alloys which are unstable in a strongly aggressive acid solution, a new kind of anode electro-chemical protection has been developed. This method gives the chemical industry a new "flank guard" against especially aggressive solutions.

In the Institute, means of protection against atmospheric corrosion have been developed with the aid of so-called volatile inhibitors (or retarders) of corrosion. These can be most conveniently used in those circumstances where it is necessary to maintain a metallic article for a long period of time and where it is impossible to paint it. Studying the relationship between a large collection of organic compounds and their inhibiting effect

on corrosion, the scientists have proposed new and more effective means of retarding corrosion.

On the other hand, the rapid development of the chemical industry and the large-scale production of polymer materials and plastics has provided an abundance of polymer film which can be used as a protective covering for metal. On this project work is being carried out in our own institute and in other scientific establishments.

None of this work is the result of a chance discovery or luck or the product of a vast quantity of aimless searching through the scientific kitchen. Their success was born as a result of specially developed systems of scientific research. How do these scientists know in what direction to look? They knew the direction because they had proceeded along the lines of the kinetics of electro-chemistry which had been established previously, as well as along the lines of other natural laws. As they say, everything was thought out beforehand.

At the December Plenum of the Central Committee of the Communist Party of the Soviet Union, the most active bureau of the section devoted to general technical chemistry in the Academy of Sciences of the USSR (academicians N. N. Semenov, A. N. Nesmeyanov, A. N. Frumkin, V. I. Spitsyn and others) made a decisiion about the necssity of increasing the theoretical work in the struggle against corrosion in the Institute of Physical Chemistry of the Academy of Sciences. We salute this timely decision and will do everything possible in order that it may be brought to life, and then the expenses for scientific research into the solution of the anti-corrosion problem, estimated perhaps at 0.1% of the overall loss which the country suffers now from metal corrosion, will be compensated many times over by the new achievements in the battle with this evil.

The fight against metal corrosion is just as necessary for the development of human society today as is a concern for the national health and the perfection

of medical science.

Article signed by: Professor N. Tomashov